MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

VOL. XXIX. *March* 12, 1869. No. 5.

Admiral MANNERS, President, in the Chair.

Col. Addison, 2nd Regiment of Foot;
Chas. Barton, Esq., H.M.S. *Conway*, Rock Ferry, Liverpool;
Rev. R. Prichard Davies, Hatfield, Herts;
Lieut. George Strahan, Uxbridge Villas, Slough;

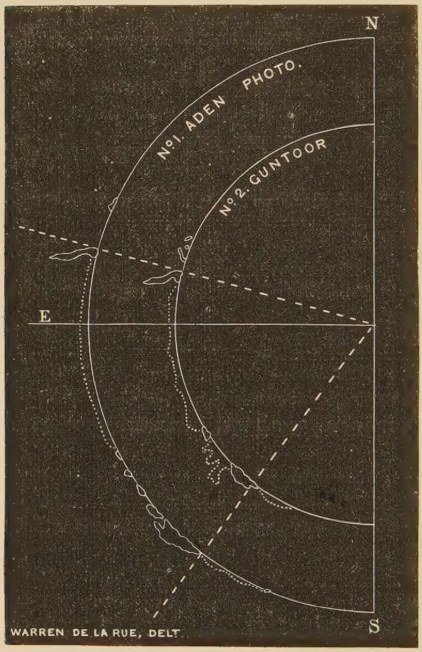
were balloted for and duly elected Fellows of the Society.

On the Aden and Guntoor Photographs of the Eclipse of the Sun, August 18, 1868. By Warren De La Rue, Esq.

In a communication published in the *Monthly Notices*, vol. xxix., No. 3, I called attention to differences in the representations of the prominence called the "Great Horn," as depicted in a woodcut of the Aden Photographs in the *Engineer* of November 6 and 13, 1868, and in the fac-similes of the drawings made by the several observers along the line of totality, when compared with the Guntoor photographs. I therein stated that these differences in the several aspects of the prominence in question might be accounted for on the supposition that it was undergoing an axial rotation during the period that it was being observed at the several stations.

I pointed out, however, that this hypothesis depended mainly upon the faithfulness of the copy of the Aden photograph, as given in the *Engineer*, and that it would not be possible to speak with certainty on this point until prints of the Aden and Guntoor

photographs had been compared. I had endeavoured to procure copies of the Aden photographs before I sent in my paper, but was not successful; since its publication, however, I have obtained a copy of No. 1 Aden photograph, through the kindness of Dr. Foerster, Director of the Berlin Observatory.



I have now the honour to lay before the Society a tracing of this photograph, combined with one of No. 2 Guntoor photograph, in such a manner that they may be directly compared.

It will be seen that there is a great difference between the woodcut of the Aden photograph in the *Engineer* and the tracing herein given; and that so far from the Great Horn being so curved that its point is directed northward, the point (as is the case in the Guntoor photographs) is directed southward; moreover, there is not much difference in the aspect of this prominence in these pictures taken 40 minutes apart. The inclination, N. towards E., however, of the point to a radius drawn tangentially to the northern boundary of the base is 6° less in the Aden photograph (24° 20′) than it is in the Guntoor photograph, 30° 20′. A comparison of the two pictures makes it evident, therefore, that some change in the direction of the Great Horn had occurred in the lapse of 40 minutes, but it is not possible to say with certainty whether or not it was due to an axial rotation of this prominence.

On the Transit of Mercury in 1868, *and on* γ^1, γ^2, *and* γ^3 *Andromedæ in Daylight.* By Thomas Barneby, Esq.

Having read accounts of the different appearances presented to different observers of the transit of *Mercury* across the disk of the Sun on the 5th November, 1868, I think an account of another observation of it, with a large refractor, may be interesting and perhaps useful.

In my locality the sky was cloudless and the air steady, and as soon as I could reach the Sun with my Equatoreal, at about $7^h\ 45^m$ G.M.T., I saw a well-defined very black but dull circular image of *Mercury* projected on the Sun. I watched it, with a friend, from that time until the time of the planet's disappearance at about $9^h\ 2^m\ 41^s$ G.M.T.

I saw no bright spot on the planet, nor any aureola around it, but I several times noticed on it a streak of light from south to north towards the west, in the shape of twisted lightning, which I attributed to ocular delusion.

I perceived no filament thrown out from the planet on approaching last internal contact, nor was there any distortion interfering with circularity, apparent to me of either celestial body during the progress of the transit, although the edge of each seemed slightly serrated.

I may mention, as a test of my telescope and of my sight, that on the 5th of February, 1869, at about $5^h\ 45^m$ G.M.T., with the same instrument, I saw γ^2 and γ^3 *Andromedæ* with a well-defined line of division between them, whilst there was daylight by which I read the R.A. and D. of their primary, and set the circles of my instrument.

γ^1 had a well-defined clean disk of a deep orange colour: γ^2 was a light yellow, and γ^3 distinctly blue. I observed to my companion, "The smaller star separated from the other is blue," without recollecting that it had been seen so before.

My view of the Sun was with a solar diagonal eye-piece, and a power of 113 applied to it, and that of γ *Andromedæ* with a direct eye-piece, and a power of 720, having the whole 9-inches aperture of my object-glass exposed on each occasion.

South Villa Observatory, near Worcester,
8 February, 1869.

Observations on the Transit of Mercury, 5th November, 1868, *Hobart Town.* By Thomas Abbott, Esq.

I transmit a diagram with the following observations, made with an equatoreally-mounted achromatic of 4-inches aperture and 5-feet focal length. Other observations were made at the same time and near the same place by an assistant, with a small Gregorian reflector. The day was more than usually fine, and the whole passage of the planet over the Sun well seen. According to the value imparted to such a transit for correcting or verifying the longitude, time being deduced from the *Nautical Almanac*, and when compared with the adopted longitude of the place, this transit, as near as observation could be made, was remarkably close.

The Royal Astronomical Society are in possession of all the means employed by Commander Kay for determining the geo-

graphical position of the Magnetic Observatory here, the whole series of observations having been reduced for them by Captain Shadwell, which gave for the longitude $9^h\ 49^m\ 29^s{\cdot}6$. Since the time this result was arrived at, Captain Denham, when stationed at Garden Island,* sent into these waters an officer and crew for the purpose of testing the longitude of Hobart Town. The result of all observations made at this time gave for the longitude $9^h\ 49^m\ 28^s{\cdot}8$, being a small difference of $0^s{\cdot}8$ (eight-tenths of a second). There remains, however, much doubt as to to the correct geographical position of any of the Australian colonies being well known. Captain Kay thinks with the Astronomer Royal that for observing the forthcoming transit of *Venus* they are not suited until better known. Mr. Ellery thinks differently, he considers the position of the Melbourne Observatory to be as well known as that of the Cape of Good Hope.

There is very great uncertainty of any expedition being able to reach either Wilks' Land or Sabrina Land in the month of December. If, therefore, some well-defined spot could be fixed upon, and suitable means employed to establish it as a starting-point for determining the correct geographical position of any other spot with equal accuracy, there would be found no difficulty in making correct, for the reception of any expedition that might be sent for the purpose, any position of the Australian Colonies, either by telegraphic communication, transmission of chronometers, or such other means as might be thought most suitable.

The Diagram accompanying the foregoing paper shows—

	h	m	s	
External contact at Ingress	3	14	9	Hobart Town M.T.
,, ,, Egress	6	52	27	,,

and least distance of line of transit from centre $= 12'\ 15''$, the Sun's semidiameter being $16'\ 11''$.

Private Observatory,
Hobart Town, Tasmania,
28 *December*, 1868.

Observations of the Transit of Mercury over the Sun's Disk on Nov. 4th, 1868, at the Royal Observatory, Cape of Good Hope, with Equations deduced therefrom. By W. Mann, First Assistant at the Observatory.

With the $8\frac{1}{2}$-foot Equatoreal, the following observations at ingress and egress were made by Sir T. Maclear and Mr. G. Maclear.

* The established place of observation for all the officers of H.M. ships visiting Sydney.

Ingress.

	Chron. Times. h m s	Cape M.T. h m s	Obs.	Remarks.
Mercury apparently bisected by the Sun's limb	18 48 16·7	18 40 3·5	T.M.	Good.
Interior contact of limbs ..	18 49 48·0	18 41 34·80	G.M.	Good.

Egress.

Interior contact of limbs ..	22 23 0·0	22 14 46·68	T.M.	
Mercury apparently bisected by the Sun's limb	22 24 16·0	22 16 2·68	T.M.	
Exterior contact of limbs ..	22 25 20·5	22 17 7·18	T.M.	

The sky was partially and thinly clouded at egress, through which the objects were seen with sufficient clearness, but the limbs were badly defined and tremulous.

The powers used were 200 at the ingress, and 440 at the egress.

The following observations were made with a divided object-glass micrometer, attached to the Dollond telescope of 46-in. focal length, and $3\frac{1}{2}$-in. aperture, employing a power of 80 throughout, and they consist of measures of the distances of both limbs of *Mercury* from the nearest and furthest points on the Sun's limb.

The four different classes of observation are distinguished by the letters A, B, C, D, thus :—

A denotes an internal contact of the limb of *Mercury* with the nearest point on the Sun's S. limb.

B denotes an external contact of the limb of *Mercury* with the nearest point on the Sun's S. limb.

C denotes an internal contact of the limb of *Mercury* with the furthest point on the Sun's N. limb.

D denotes an external contact of the limb of *Mercury* with the furthest point on the Sun's N. limb.

The plan of operations it was proposed to follow during the progress of the transit was only partially and imperfectly carried out, owing to the unfavourable state of the sky.

From the commencement to set (6), the sky was clear, and the images of the Sun and planet, although faint, were sharp and steady ; but from set (7) to the close, the Sun was repeatedly clouded, and the observations for the most part were obtained with great difficulty, and their accuracy undoubtedly much impaired by the extreme faintness and indistinctness of the images.

With three exceptions, five measures of each contact of the limbs were obtained ; and the mean of the measures is considered sensibly to correspond with the mean of the times.

The following table contains all the measures that were taken, with the chronometer times, and the means of each group.

No. of Set.	Class of Obs.	Chron. Times. h m s	Scale Reading.	Remarks.
1	A	18 51 10	0·081	
		52 12	·090	
		53 34	·104	
		54 45	·116	
		55 28	·123	
		18 53 25·8	0·1028	
2	B	18 57 45	0·162	
		58 21	·168	
		58 56	·174	
		59 40	·178	
		60 16	·184	
		18 58 59·6	0·1732	
3	C	19 4 22	4·433	
		5 30	·430	
		6 2	·422	
		7 5	·414	
		7 35	·409	
		19 6 2·8	4·4126	
4	D	19 8 18	4·424	
		8 57	·420	
		9 42	·414	
		10 13	·411	
		11 16	·402	
		19 9 41·2	4·4142	
5	A	19 15 28	0·273	
		16 7	·280	
		16 45	·282	
		17 17	·286	
		18 10	·291	
		19 16 45·4	0·2824	
6	B	19 19 21	0·320	
		19 58	·324	
		20 43	·333	
		21 19	·338	
		22 2	·344	
		19 20 40·6	0·3318	

No. of Set.	Class of Obs.	Chron. Times. h m s	Scale Reading.	Remarks.
7	C	19 25 8	4·278	Clouded; both objects very faint.
		25 52	·275	
		26 28	·272	
		27 10	·269	
		28 15	·260	
		19 26 34·6	4·2708	
8	D	19 29 18	4·274	Clouded; both objects very faint.
		30 36	·272	
		32 40	·258	
		33 30	·253	
		34 23	·247	
		19 32 5·4	4·2608	
9	A	19 37 24	0·412	Clouds.
		38 30	·419	
		39 13	·421	
		39 58	·425	
		43 35	·442	
		19 39 44·0	0·4238	
10	B	19 45 12	0·474	The Sun frequently obscured by cloud.
		46 35	·482	
		48 32	·490	
		51 8	·498	
		53 6	·510	
		19 48 54·6	0·4908	
11	D	20 5 3	4·123	In these measures the contact at the S. limb of *Mercury* instead of the N. limb was inadvertently taken.
		5 26	·125	
		6 7	·122	
		20 5 32·0	4·1233	
12	C	20 16 22	4·083	From 20^h to $20^h\ 30^m$ a few glimpses only of the Sun were obtained.
		16 58	·076	
		20 16 40	4·0795	
13	D	20 30 54	4·090	After taking this set the Sun became wholly obscured for about 45^m.
		31 38	·091	
		32 18	·097	
		33 0	·097	
		33 32	·098	
		20 32 16·4	4·0946	

No. of Set.	Class of Obs.	Chron. Times. h m s	Scale Reading.	Remarks.
14	A	21 36 7	0·310	
		36 44	·306	
		37 25	·300	
		38 12	·298	
		38 40	·292	
		21 37 25·6	0·3012	
15	B	21 39 25	0·311	
		39 55	·307	
		40 22	·308	
		41 8	·300	
		41 55	·295	
		21 40 33·0	0·3042	
16	C	21 46 20	4·388	The Sun clouded; the observations very uncertain.
		48 16	·408	
		49 0	·406	
		51 42	·430	
		52 23	·432	
		21 49 33·2	4·4128	
17	D	21 53 5	4·457	Clouded; the observations very uncertain.
		53 40	·459	
		54 17	·463	
		55 5	·477	
		55 45	·478	
		21 54 22·4	4·4668	
18	A	22 7 44	0·064	
		8 4	·066	
		8 25	·062	
		9 0	·055	
		9 28	·051	
		22 8 32·2	0·0596	
19	B	22 10 0	0·064	Very faint; further observation impracticable.
		10 32	·060	
		22 10 16·0	0·0620	

The above measures were made by myself, the scale being read by Mr. Sinfield.

The chronometer errors, obtained from comparisons with the transit-clock before and after the observations were, at $18^h\ 16^m\ 50^s$,

chronometer fast $23^{s}\cdot75$, and at $22^{h}\ 28^{m}\ 0^{s}$ fast, $24^{s}\cdot09$ on Cape Mean Solar Time.

The scale value in arc was deduced from a set of measures of the Sun's horizontal diameter at $22^{h}\ 45^{m}$; twelve measures gave 4·6540 in., or corrected for index error, 4·6567 for the apparent diameter; and the tabular value being $32'\ 21''\cdot56$, we have

$$1 \text{ inch on the Scale} = \frac{1941''\cdot56}{4\cdot6567} = 416''\cdot94.$$

The index error of the scale was derived from contacts of the moveable image of *Mercury* at alternate sides of the fixed image. Six positive and six negative readings gave 0·0027-in. for the correction to be *added* to a scale reading.

The following table contains an abstract of the means of the foregoing groups of observations, the times being corrected for chronometer error, and the scale readings corrected for index error, and converted into arc.

Set.	Class of Measure.	Cape Mean Times. h m s	Measure. ′	No. of Measures.
1	A	18 53 2·0	43·99	5
2	B	58 35·8	73·34	5
3	C	19 5 39·0	1844·66	5
4	D	9 17·4	1841·58	5
5	A	16 21·6	118·87	5
6	B	20 16·8	139·47	5
7	C	26 10·8	1781·79	5
8	D	31 41·5	1777·62	5
9	A	39 20·1	177·82	5
10	B	48 30·7	205·76	5
11	D	20 5 8·1	1720·29	3
12	C	16 16·1	1702·03	2
13	D	31 52·5	1708·32	5
14	A	21 37 1·6	126·71	5
15	B	40 9·0	127·96	5
16	C	49 8·2	1841·00	5
17	D	53 58·4	1863·50	5
18	A	22 8 8·1	25·98	5
19	B	9 51·9	26·98	2

In addition to the foregoing, the times of external and internal contact at ingress were noted as follow:—

	h m s		h m s	
External contact of limbs	18 40 6	by chron. or	18 39 42·2	Cape M.T.
Internal contact ,,	18 41 58	,,	18 41 34·2	,,

The time of external contact is of little value, and the instant

of internal contact is not very accurate, owing to an indistinctness of limb caused by a slight overlap of the images in a direction at right angles to the line of section of the lenses.

In consequence of this error of adjustment—for the correction of which no means exist in this instrument—measures of the diameter of *Mercury* were not attempted with the divided object-glass.

Reduction of the Observations.

The first step was the calculation of the apparent distances of the centres of the Sun and *Mercury* for the times of ingress and egress observed with the $8\frac{1}{2}$-foot Equatoreal, taking the contacts of the limbs only; also for the times given in the foregoing abstract of measures, and with elements derived from the *Nautical Almanac*.

With Greenwich Mean Solar times corresponding to the above Cape Mean Solar times, the Right Ascensions and South Polar Distances of the Sun and *Mercury* were interpolated with second and third differences.

The parallaxes in Right Ascension and Polar Distance were calculated with the aid of tables adapted to the latitude of the place, and of a similar form to those described in various Introductions to the Greenwich Observations, containing quantities D and θ, calculated for every minute of hour-angle, and determined by the formulæ

$$\text{Sin D} = \text{sin geocentric colat.} \times \text{sin hour-angle},$$
$$\tan\theta = \text{tan geocentric colat.} \times \text{cos hour-angle},$$

with which we obtain

$$\text{the Parallax in R.A. (in arc)} = \frac{\text{hor. eq. parallax} \times r \times \sin \text{D}}{\sin \text{S.P.D.}}$$
$$\text{the Parallax in P.D.} = \text{hor. eq. parallax} \times r \,.\, \cos \text{D} \,.\, \sin(\text{S.P.D.} - \theta)$$

r being the geocentric radius for the Cape, in terms of the equatoreal radius.

The tabular and the apparent Right Ascensions and South Polar Distances of the Sun and *Mercury* are exhibited in the subjoined table. The numerals I, II, and III, in the first column serve to distinguish the quantities depending on the time of internal contact at ingress and the times of internal and external contact at egress; the other numerals refer to the observations made with the divided object-glass.

In the calculation of the parallaxes in R.A. and S.P.D. the tabular equatoreal horizontal parallax of *Mercury* was taken $= 12''{\cdot}70$, and that of the Sun $= 8''{\cdot}66$.

No. of Set.	Sun's Tabular R.A.	Par. in R.A.	Sun's Apparent R.A.	Sun's Tabular S.P.D.	Par. in S.P.D.	Sun's Apparent S.P.D.
	° ′ ″	″	° ′ ″	° ′ ″	″	° ′ ″
I	220 39 20·07	7·24	220 39 27·31	74 12 57·85	4·14	74 13 1·99
1	39 48·51	7·14	39 55·65	12 49·18	4·04	12 53·22
2	40 2·36	7·08	40 9·44	12 44·96	4·00	12 48·96
3	40 19·88	7·00	40 26·88	12 39·62	3·94	12 43·56
4	40 28·94	6·96	40 35·90	12 36·86	3·91	12 40·77
5	40 46·52	6·87	40 53·39	12 31·51	3·86	12 35·37
6	40 56·25	6·82	41 3·07	12 28·54	3·83	12 32·37
7	41 10·92	6·74	41 17·66	12 24·07	3·78	12 27·85
8	41 24·62	6·66	41 31·28	12 19·90	3·74	12 23·64
9	41 43·64	6·54	41 50·18	12 14·11	3·68	12 17·79
10	42 6·45	6·39	42 12·84	12 7·16	3·61	12 10·77
11	42 47·78	6·10	42 53·88	11 54·58	3·49	11 58·07
12	43 15·48	5·88	43 21·36	11 46·15	3·42	11 49·57
13	43 54·27	5·55	43 59·82	11 34·35	3·32	11 37·67
14	46 36·12	3·93	46 40·05	10 45·05	2·96	10 48·01
15	46 44·06	3·84	46 47·90	10 42·69	2·94	10 45·63
16	47 6·41	3·58	47 9·99	10 35·89	2·90	10 38·79
17	47 18·44	3·44	47 21·88	10 32·24	2·88	10 35·12
18	47 53·66	3·03	47 56·69	10 21·53	2·83	10 24·36
19	47 57·98	2·98	48 0·96	10 20·22	2·83	10 23·05
II	48 10·20	2·83	48 13·03	10 16·51	2·81	10 19·32
III	220 48 16·02	2·76	220 48 18·78	74 10 14·73	2·80	74 10 17·53

No. of Set.	Mercury's Tabular R.A.	Par. in R.A.	Mercury's Apparent R.A.	Mercury's Tabular S.P.D.	Par. in S.P.D.	Mercury's Apparent S.P.D.
	° ′ ″	″	° ′ ″	° ′ ″	″	° ′ ″
I	220 43 27·54	10·63	220 43 38·17	73 57 23·65	6·05	73 57 29·70
1	42 53·12	10 48	43 3·60	57 44·49	5·91	57 50·40
2	42 36·39	10·40	42 46·79	57 54·62	5·84	58 0·46
3	42 15·20	10·28	42 25·48	58 7·45	5·76	58 13·21
4	42 4·25	10·22	42 14·47	58 14·09	5·71	58 19·80
5	41 43·01	10·09	41 53·10	58 26·95	5·63	58 32·58
6	41 31·22	10·02	41 41·24	58 34·09	5·59	58 39·68
7	41 13·49	9·90	41 23·39	58 44·82	5·52	58 50·34
8	40 56·93	9·78	41 ·6·71	58 54·85	5·45	59 0·30
9	40 33·95	9·61	40 43·56	59 8·77	5·37	59 14·14
10	40 6·39	9·38	40 15·77	59 25·47	5·27	59 30·74
11	39 16·47	8·94	39 25·41	59 55·72	5·09	74 0 0·81
12	38 43·02	8·62	38 51·64	74 0 15·99	4·98	0 20·97
13	37 56·15	8·14	38 4·29	0 44·40	4·83	0 49·23
14	34 40·58	5·73	34 46·31	2 43·01	4·31	2 47·32
15	34 31·22	5·60	34 36·82	2 48·69	4·29	2 52·98
16	34 4·25	5·22	34 9·47	3 5·06	4·23	3 9·29
17	33 49·76	5·02	33 54·78	3 13·86	4·20	3 18·06

No. of Set.	Mercury's Tabular R.A.	Par. in R.A.	Mercury's Apparent R.A.	Mercury's Tabular S.P.D.	Par. in S.P.D.	Mercury's Apparent S.P.D.
	° ′ ″	″	° ′ ″	° ′ ″	″	° ′ ″
18	220 33 7·28	4·40	220 33 11·68	74 3 39·64	4·13	74 3 43·77
19	33 2·09	4·32	33 6·41	3 42·79	4·12	3 46·91
II	32 47·35	4·11	32 51·46	3 51·74	4·09	3 55·83
III	220 32 40·33	4·00	220 32 44·33	3 56·00	4·08	74 4 0·08

If now we put

a for the excess of the apparent R.A. of the Sun's centre above that of *Mercury's* centre;

p for the excess of the apparent S.P.D. of the Sun's centre above that of *Mercury's* centre;

Δ and δ for the S.P.D.'s of the Sun and *Mercury*;

then, the apparent distance of the centres $(c) = p \sec \zeta$,

$$\text{where } \tan \zeta = \frac{a}{p} \sqrt{\sin \Delta \sin \delta}.$$

Also, let σ and μ be the semidiameters of the Sun and *Mercury*, and m' the tabular value of the measured distance of the limbs; then for the several classes of observations with the divided object-glass micrometer, we shall have

For Class A, $m' = \sigma - \mu - c$, Class C, $m' = \sigma - \mu + c$,

B, $m' = \sigma + \mu - c$, D, $m' = \sigma + \mu + c$,

At the instant of ingress or egress, $m' = 0$

and we have

For the internal contact, $c = \sigma - \mu$; for the external contact, $c = \sigma + \mu$.

Substituting the tabular values of σ and μ, viz. $\sigma = 970''{\cdot}78$ and $\mu = 4''{\cdot}94$, we have

For A, $m' = 965''{\cdot}84 - c$ for C, $m' = 965''{\cdot}84 + c$

B, $m' = 975''{\cdot}72 - c$ D, $m' = 975''{\cdot}72 + c$

The values of a, p, c, and m', are given below:—

No. of Set.	Class of Observation.	a.	p.	c.	m'.
		′ ″	′ ″	″	″
I	A	− 4 10·86	15 32·29	963·00	0·00
1	A	3 7·95	15 2·82	920·74	45·10
2	B	2 37·35	14 48·50	901·29	74·43
3	C	1 58·60	14 30·35	877·79	1843·63
4	D	1 38·57	14 20·97	866·17	1841·89
5	A	0 59·71	14 2·79	844·74	121·10
6	B	0 38·17	13 52·69	833·50	142·22
7	C	− 0 5·73	13 37·51	817·53	1783·37

No. of Set.	Class of Observation.	a.	p.	c.	m.
		′ ″	′ ″	″	″
8	D	+ 0 24·57	13 23·34	803·69	1779·41
9	A	1 6·62	13 3·65	786·26	179·58
10	B	1 57·07	12 40·03	768·32	207·40
11	D	3 28·47	11 57·26	744·75	1720·47
12	C	4 29·72	11 28·60	735·84	1701·68
13	D	5 55·53	10 48·44	733·07	1708·79
14	A	11 53·74	8 0·69	838·04	127·80
15	B	12 11·08	7 52·65	847·25	128·47
16	C	13 0·52	7 29·50	875·00	1840·84
17	D	13 27·10	7 17·06	890·86	1866·58
18	A	14 45·01	6 40·59	940·77	25·07
19	B	14 54·55	6 36·14	947·22	28·50
II	A	15 21·57	6 23·49	965·79	0·00
III	B	+15 34·45	6 17·45	974·82	0·00

Correction of the Measured Distances of the Limbs for the Effects of Refraction.

Calling the vertical refraction $= \varkappa \tan z$, where z is the apparent zenith distance; also putting γ for the inclination of the measured distance m, to the vertical circle passing through its middle point; then the effect of the refraction on the measured distance will be given by the formula

$$\varkappa m \sec^2 \psi \sin 1'', \text{ where } \tan \psi = \cos \gamma \tan z.$$

It will be sufficiently accurate for all the cases considered in the present discussion to calculate z and γ for the centre of the Sun at the instant of observation.

With the Sun's hour-angle and S.P.D, and with the aid of tables calculated for the latitude of the Cape, having arguments to every minute of hour-angle, the values of z_0 the true zenith distance, and of S. his angle of situation were readily obtained. The true zenith distances were easily converted into apparent Z.D.'s with the aid of a table of refractions; and the values of γ were found with all requisite accuracy from the expression $\gamma = S - \zeta$, where ζ, which is already calculated, is the inclination of the distance of the centres c to the circle of declination passing through its middle point.

The principal numerical quantities involved in the calculation of the corrections for refraction, together with the measures corrected and compared with the tabular values are given below.

The following are the readings of the barometer and thermometer used in calculating the values of log $\varkappa$ from the table of refraction:—

Set 1 to 10		Set 11 to 13		Set 14 to 19	
Bar.	30in·19	Bar.	30in·20	Bar.	30in·22
Ther.	Att. 58°·0 Out 54°·0	Ther.	Att. 59° Out 56°	Ther.	Att. 60° Out 58°·5

Set.	Sun's Hour Angle.	Apparent Z.D. of Sun's Centre (z).	Angle of Situation (s).	ξ.	γ.
	h m s	° ′	° ′	° ′	° ′
1	4 50 42	67 2	59 19	−11 19	70 38
2	4 45 8	65 53	59 24	9 40	69 4
3	4 38 5	64 25	59 29	7 28	66 57
4	4 34 26	63 40	59 31	6 17	65 48
5	4 27 32	62 14	59 33	3 54	63 27
6	4 23 27	61 23	59 34	2 31	62 5
7	4 17 33	60 10	59 34	− 0 23	59 57
8	4 12 2	59 2	59 33	+ 1 41	57 52
9	4 4 24	57 27	59 29	4 45	54 49
10	3 55 13	55 32	59 22	8 26	50 56
11	3 38 36	52 7	59 1	15 37	43 24
12	3 27 28	49 49	58 39	20 39	38 0
13	3 11 51	46 37	57 57	27 48	30 9
14	2 6 42	33 44	51 39	55 0	3 21
15	2 3 35	33 9	51 10	56 6	4 56
16	1 54 36	31 29	49 38	59 5	9 27
17	1 49 45	30 36	48 40	60 37	11 57
18	1 35 36	28 6	45 31	64 48	19 17
19	1 33 52	27 48	45 5	+65 17	20 12

Set.	Log α.	Corr. for Refr.	Measured Distance.	Meas. Dist. Corr. for Refr. (m).	Calculated Distance. (m').	$m - m'$.
		″	″	″	″	″
1	1·7619	0·02	43·99	44·01	45·10	−1·09
2	1·7622	0·03	73·34	73·37	74·43	−1·06
3	1·7624	0·86	1844·66	1845·52	1843·63	+1·89
4	1·7626	0·87	1841·58	1842·45	1841·89	+0·56
5	1·7628	0·06	118·87	118·93	121·10	−2·17
6	1·7630	0·07	139·47	139·54	142·22	−2·68
7	1·7631	0·88	1781·79	1782·67	1783·37	−0·70
8	1·7633	0·89	1777·62	1778·51	1779·41	−0·90
9	1·7634	0·09	177·82	177·91	179·58	−1·67
10	1·7636	0·11	205·76	205·87	207·40	−1·53
11	1·7623	0·90	1720·29	1721·19	1720·47	+0·72
12	1·7624	0·89	1702·03	1702·92	1701·68	+1·24
13	1·7626	0·88	1708·32	1709·20	1708·79	+0·41
14	1·7611	0·05	126·71	126·76	127·80	−1·04
15	1·7611	0·05	127·96	128·01	128·47	−0·46
16	1·7611	0·70	1841·00	1841·70	1840·84	+0·86
17	1·7611	0·70	1863·50	1864·20	1866·58	−2·38
18	1·7612	0·01	25·98	25·99	25·07	+0·92
19	1·7612	0·01	26·98	26·99	28·50	−1·51

Formation of Equations of Condition involving Corrections to the Elements of Computation.

Let

x be the correction to the tabular excess of the Sun's R.A. above *Mercury's* R.A. (in arc);

y be the correction to the tabular excess of the Sun's S.P.D. above *Mercury's* S.P.D.

$d\pi$ the correction to the excess of the parallax of *Mercury* above that of the Sun;

$d\sigma$ and $d\mu$ the corrections to the semidiameters of the Sun and *Mercury*.

Also, let

τ seconds be the correction to the assumed longitude of the Observatory,

that is to say, let the true longitude be

$$-\ 1^{h}\ 13^{m}\ 55^{s} + \tau \text{ sec.}$$

then, since the relative motions in R.A. and S.P.D. in 1^{s} of time are

$$+\ 0''{\cdot}0915 \text{ and } -\ 0''{\cdot}0429 \text{ respectively,}$$

we shall have the corrections to a and p, or da and dp, sensibly, as follows:—

$$da = x + {\cdot}0915\,\tau - \varkappa\, d\pi$$
$$dp = y - {\cdot}0429\,\tau - \varkappa'\, d\pi$$

$\varkappa$ and $\varkappa'$ being the coefficients of parallax in R.A. and S.P.D.

Now, since the corrections are all small, we have from the expression $C^2 = a^2 \sin \Delta \sin \delta + p^2$, considering C, a, and p only to vary,

$$dc = \frac{a}{c} \sin \Delta \sin \delta \,.\, da + \frac{p}{c}\, dp,$$

and the final equations for the observed times of ingress and egress will be—

For I. and II. $\sigma - \mu - c = dc - d\sigma + d\mu$; for III. $\sigma + \mu - c = dc - d\sigma - d\mu$.

Also,

$$\text{putting } m = m' + dm',$$

m being the measured and m' the computed distance of the limbs, the final equations for the observations made with the divided object-glass micrometer will be

For class A, $dm' = d\sigma - d\mu - dc$ For class C, $dm' = d\sigma - d\mu + dc$

B, $dm' = d\sigma + d\mu - dc$ D, $dm' = d\sigma - d\mu + dc$

But since a correction $d\sigma$ to the Sun's semidiameter will cause

a change in the arc value of the measured quantity m, $d\sigma$ in the four last equations must be multiplied by a factor of the form $(1 - q)$, where $q = 2\frac{m}{m_0}$, m_0 being the scale measure of the Sun's diameter.

Introducing the numerical value of $d\,a$, $d\,p$, and c, and reducing, we obtain finally—

No. of Equation.							
I.	$-2''\cdot84 = +1''\cdot000\,d\sigma$	$-1''\cdot000\,d\mu$	$+0''\cdot241x$	$-''\cdot968\,y$	$+''\cdot064\,\tau$	$+''\cdot260\,d\Pi$
1	$-1''\cdot09 = +0''\cdot955$	$-1''\cdot000$	$+0''\cdot189$	$-''\cdot981$	$+''\cdot059$	$+''\cdot301$
2	$-1''\cdot06 = +0''\cdot925$	$+1''\cdot000$	$+0''\cdot162$	$-''\cdot986$	$+''\cdot057$	$+''\cdot322$
3	$-1''\cdot89 = +0''\cdot900$	$+1''\cdot000$	$+0''\cdot125$	$-''\cdot992$	$+''\cdot054$	$+''\cdot349$
4	$-0''\cdot56 = +0''\cdot897$	$-1''\cdot000$	$+0''\cdot105$	$-''\cdot994$	$+''\cdot052$	$+''\cdot363$
5	$-2''\cdot17 = +0''\cdot878$	$-1''\cdot000$	$+0''\cdot065$	$-''\cdot998$	$+''\cdot049$	$+''\cdot391$
6	$-2''\cdot68 = +0''\cdot856$	$+1''\cdot000$	$+0''\cdot042$	$-''\cdot999$	$+''\cdot047$	$+''\cdot407$
7	$+0''\cdot70 = +0''\cdot835$	$+1''\cdot000$	$+0''\cdot007$	$-1''\cdot000$	$+''\cdot044$	$+''\cdot430$
8	$+0''\cdot90 = +0''\cdot831$	$-1''\cdot000$	$-0''\cdot028$	$-1''\cdot000$	$+''\cdot040$	$+''\cdot452$
9	$-1''\cdot67 = +0''\cdot817$	$-1''\cdot000$	$-0''\cdot078$	$-''\cdot997$	$+''\cdot036$	$+''\cdot482$
10	$-1''\cdot53 = +0''\cdot788$	$+1''\cdot000$	$-0''\cdot141$	$-''\cdot989$	$+''\cdot030$	$+''\cdot515$
11	$-0''\cdot72 = +0''\cdot773$	$-1''\cdot000$	$-0''\cdot259$	$-''\cdot963$	$+''\cdot818$	$+''\cdot569$
12	$-1''\cdot24 = +0''\cdot754$	$+1''\cdot000$	$-0''\cdot339$	$-''\cdot936$	$+''\cdot009$	$+''\cdot597$
13	$-0''\cdot41 = +0''\cdot760$	$-1''\cdot000$	$-0''\cdot449$	$-''\cdot885$	$-''\cdot003$	$+''\cdot625$
14	$-1''\cdot04 = +0''\cdot870$	$-1''\cdot000$	$-0''\cdot788$	$-''\cdot574$	$-''\cdot048$	$+''\cdot551$
15	$-0''\cdot46 = +0''\cdot868$	$+1''\cdot000$	$-0''\cdot798$	$-''\cdot558$	$-''\cdot049$	$+''\cdot541$
16	$-0''\cdot86 = +0''\cdot896$	$+1''\cdot000$	$-0''\cdot825$	$-''\cdot514$	$-''\cdot054$	$+''\cdot512$
17	$+2''\cdot38 = +0''\cdot920$	$-1''\cdot000$	$-0''\cdot838$	$-''\cdot491$	$-''\cdot056$	$+''\cdot495$
18	$+0''\cdot92 = +0''\cdot973$	$-1''\cdot000$	$-0''\cdot870$	$-''\cdot426$	$-''\cdot061$	$+''\cdot441$
19	$-1''\cdot51 = +0''\cdot972$	$+1''\cdot000$	$-0''\cdot874$	$-''\cdot418$	$-''\cdot062$	$+''\cdot434$
II.	$-0''\cdot05 = +1''\cdot000$	$-1''\cdot000$	$-0''\cdot883$	$-''\cdot397$	$-''\cdot064$	$+''\cdot415$
III.	$-0''\cdot90 = +1''\cdot000$	$+1''\cdot000$	$-0''\cdot887$	$-''\cdot387$	$-''\cdot065$	$+''\cdot405$

These equations alone are obviously unfitted for the determination of all the unknown quantities; and, moreover, considering the circumstances under which many of the observations were taken, we should not be justified in assigning an equal weight to them throughout. Values of the weights might be inferred from a consideration of the individual observations, but I have not prosecuted the inquiry further, under the belief that, when the objects were seen faintly through cloud, *constant* errors in the measured distances were as much to be feared as *accidental* errors of observation.

Approximate values of $d\,\mu$, x and y may be obtained as follows:—

If we take as one equation the mean of Nos. 11 and 13 (No. 11 having been observed by mistake at the S. limb of *Mercury*), and if we exclude I., the remaining twenty equations will give a

series depending upon equally-balanced observations at both limbs of the planet.

Changing the signs of the equations containing negative values of $d\mu$, and adding, we get

$$20\,d\mu = -\,8''{\cdot}485 + {\cdot}114\,d\sigma + {\cdot}148\,x - {\cdot}003\,y + {\cdot}003\,\tau - {\cdot}024\,d\pi,$$

or sensibly,

$$d\mu = -\,0''{\cdot}424.$$

Again, adding together equations 1 to 10, and equations II. to III., considering as before, the mean of 11 and 13 to form one equation, $d\mu$ is eliminated, and we have—

$$-\,11''{\cdot}05 = 8{\cdot}682\,d\sigma + 0{\cdot}448\,x - 9{\cdot}936\,y + 0{\cdot}468\,\tau + 4{\cdot}012\,d\pi,$$
$$-\,3''{\cdot}225 = 9{\cdot}020\,d\sigma - 7{\cdot}456\,x - 5{\cdot}625\,y - 0{\cdot}443\,\tau + 4{\cdot}998\,d\pi,$$

whence

$$x = -\,0''{\cdot}380 + 0{\cdot}532\,d\sigma - 0{\cdot}092\,\tau + 0{\cdot}352\,d\pi,$$
$$y = +\,1''{\cdot}095 + 0{\cdot}898\,d\sigma + 0{\cdot}043\,\tau + 0{\cdot}420\,d\pi.$$

Assuming the parallaxes to be increased by $\frac{1}{10}$th part, we have $d\pi = +\,0''{\cdot}13$; and taking $d\sigma = -\,1''{\cdot}1$, the correction given by the Greenwich Observations of the solar eclipse of 1860, we obtain finally, bearing in mind that y is the correction to the excess of S.P.D.—

Correction to excess of Sun's R.A. over *Mercury's* R A. $= -\,0''{\cdot}92 - {\cdot}092\,\tau$,
Correction to excess of Sun's N.P.D. over *Mercury's* N.P.D. $= -\,0''{\cdot}16 - {\cdot}043\,\tau$.

Sir T. Maclear, Director of the Observatory, writes :—

I annex the following, derived from my observations with the $8\frac{1}{2}$-foot Equatoreal, to Mr. Mann's elaborate discussion of his observations with the other instruments.

My wish to obtain a good determination of the diameter of *Mercury* was in a great measure frustrated by frequent interruptions from clouds and indifferent definitions after the first hour of the transit.

Under the powers 200 and 440 the planet presented the image of a black round disk, and (when the definition was good) surrounded by a very faint appearance of light. G. W. H. Maclear observed the first internal contact. I looked immediately after and noted three or four minute black dots in the narrow space between the limbs. I fancied something similar immediately before the last internal contact, but the limbs then were in violent apparent motion. I used a blue-glass eye-screen fixed to a diagonal eye-piece.

The micrometer of the $8\frac{1}{2}$-foot Equatoreal has only one micrometer screw. There is a zero wire parallel to the micrometer wire, which can be placed at any part of the field. Therefore the telescope must be moved to supply the place of a second micrometer, by trial and error tapping with the finger.

The measures for diameter were in polar distance and by "cross" observation to eliminate the coincidence of the wires. Thus each recorded measure embraced twice the diameter.

One revolution of the micrometer-screw $= 26''{\cdot}069$, and the sum of the thickness of the wires $= 1''{\cdot}737$.

Each of the following results is the mean of five partial measures of the double diameter:—

Cape Mean Time. h m				
18 59	...	...	...	0″·5662
19 12	...	...	...	0·5708
19 22	...	...	...	0·5970
21 47	...	...	...	0·5818
21 59	...	...	...	0·5636
	Mean	...	...	= 0·5759 = 15″·013
				7·507
	Half thickness of wires			·869
	Observed diameter			8·376 Probable error ± 0·11.

This result is less than the tabular diameter by $1''{\cdot}50$.

On the Observations of the Transit of Venus in 1874.

By G. B. Airy, Esq., Astronomer Royal.

In the *Compte Rendu* of the French Academy for 1869, February 8, M. V. Puiseux has courteously adverted to my late paper on the Transits of *Venus*, and has suggested that the Transit of 1874 can be advantageously observed by the method of comparison of the intervals between ingress and egress, the ingress and egress being both observed at each of the places adopted for comparison. And he has pointed out stations which give a difference of such intervals a very little larger than the intervals which I have adopted, and intimates that the method suggested by him is perhaps, therefore, superior to mine.

It will be seen in the *Monthly Notices* for 1857, May 8, page 213, second paragraph, and pages 214 and 215, that I had fully considered the method which M. Puiseux has now suggested, and that I had actually named the principal stations which M. Puiseux has now indicated. The matter having thus been fully present to my mind, I can at once explain my reasons for preferring the course which I have lately placed before the Society.

In M. Puiseux's plan the available time-determination will depend on the aggregate (not the mean) of four observations of ingress and egress. In my plan the available time-determination will depend on the aggregate of two observations of ingress or egress and two determinations of geographical longitude. And the practical question is, Which of these methods is subject to the smaller probable error?

Now I hope that, with reasonable care, the probable error of the geographical longitude will not be more than one-half of the probable error of ingress or egress. Moreover, the geographical position remains, and observations can be repeated in future years for the correction of its longitude; but nothing can repair error in the observation of ingress or egress. These points being considered, in combination with the circumstance that the effects of parallax obtained are sensibly equal, I cannot hesitate in maintaining the opinion that my method is the more accurate.

But I trust that the plan proposed by M. Puiseux will still be carried out. Every series of observations which can really be brought to bear upon this important determination will be valuable.

Royal Observatory, Greenwich,
1869, *February* 23.

Note on the Transit of Venus in 1874; *and an exact Determination of those Points on the Earth's Surface at which internal contacts are most accelerated and retarded by Parallax. With an Addendum referring to the possibility of determining the Solar Parallax by the same sort of Observations in* 1874 *as were made in* 1769. By Richard A. Proctor, B.A.

Having applied geometrical tests to the elements discussed in the paper and maps by the Astronomer Royal (*Monthly Notices*, December 11, 1868), I was led to suspect that some of the corrections which would come to be applied in an exact calculation of the circumstances of the two Transits of *Venus* would be larger than a first view of the subject might suggest I now present some of the results to which my examination of the Transit of 1874 has led me, reserving for a future occasion the examination of the Transit of 1882.

I premise that internal contacts are the phenomena to be specially considered; so that, although I have calculated the position angles for external contacts and passages of *Venus's* centre, I have not thought it necessary to determine the exact points on the Earth's surface at which these phenomena are most affected by parallax. I must also add that I have taken as the basis of my calculation the following elements calculated by Mr. Hind, and obligingly furnished me by the Astronomer Royal.

Transit of *Venus*, December 8th, 1874.

For the centre of the Earth.

Ingress.

	h	m	s	
External contact	13	46	56	Greenwich Mean Solar Time.
Internal contact	14	15	57	,, ,,

Egress.

Internal contact	17	57	5	,, ,,
External contact	18	26	5	,, ,,

The elements sent me also contained the position-angles for external contacts, but as these were only given to tenths of degrees, I preferred to recalculate them.

From an examination of these elements I learn that the estimated diameter of *Venus* is about 7364 miles, corresponding to an apparent semidiameter of $8''{\cdot}305$ at the Earth's mean distance, and an assumed equatorial horizontal solar parallax of $8''{\cdot}94$.

The Sun's longitude on December 8, 1874, at 16^h, I estimate at $256^\circ\ 57'$ (with sufficient approximation); the apparent inclination of the Sun's ecliptical diameter to a declination-parallel $5^\circ\ 36'$ (the western end raised towards the north); the Sun's declination $22^\circ\ 49'$ S.

The formulæ I have used are founded on the following considerations. Conceive the Sun and Earth enclosed in a cone whose vertex is beyond the Earth, and also in a double cone whose vertex lies between the Earth and the Sun. These cones will have a common axis,—namely, the Earth's radius vector. Now, it is obvious that when *Venus* has reached the surface of the outer cone, a transit commences at a certain point on the Earth's surface. As soon as *Venus* has reached the surface of the inner cone, transit has begun for all places on the Earth's illuminated hemisphere. The former contact corresponds to the case of ingress accelerated by parallax, the latter to the case of ingress retarded by parallax. Similar considerations apply to egress as affected by parallax.

It is clear that if we suppose the Earth's radius-vector reduced to rest and the motion of *Venus* correspondingly retarded, the remaining motion of *Venus* is that with which she may be assumed to traverse the section of the pair of cones above described. Thus it is easy to calculate the duration of a central passage for external and internal contacts, or for the centre of *Venus*, and either for the outer or inner cone, or for a cone between the two having the Earth's centre for vertex. The case of external contacts for the last-mentioned cone gives the duration of a central transit as seen from the Earth's centre; and by comparing this duration with that given in Mr. Hind's

elements, we can tell how far the transit of 1874 differs from a central one.

On such considerations the following formulæ and calculations are founded :—

Let D = Sun's diameter.
d = Earth's mean distance.
d' = *Venus's* mean distance.
r = Earth's actual distance.
r' = *Venus's* actual distance.
v = Earth's mean velocity.
v' = *Venus's* mean velocity.
Δ = Earth's mean diameter.
Δ' = *Venus's* mean diameter.
i = inclination of *Venus's* orbit.

Then $v' = v\sqrt{\frac{d}{d'}}$; the actual velocity of the Earth is $v\,\frac{d}{r}$ (very nearly); that of *Venus* is $v\sqrt{\frac{d}{d'}}\cdot\frac{d'}{r'} = v\,\frac{\sqrt{d\,d'}}{r'}$; velocity of the Earth's radius vector at *Venus's* distance is $v\,\frac{d\,r'}{r^2}$. Whence it readily follows that the actual velocity with which *Venus* crosses the section of the cones described above is

$$v = \sqrt{\left\{\frac{\sqrt{d\,d'}}{r'} - \frac{d\,r'}{r^2}\cos i\right\}^2 + \left\{\frac{d\,r'}{r^2}\sin i\right\}^2}$$

$$v = \sqrt{(d^2 r'^4 + d\,d' r'^4 - 2\,d^{\frac{3}{2}} d'^{\frac{3}{2}} r^2 r'^2 \cos i)} \div r^2 r'$$

$$= \mathrm{V}, \text{ suppose.}$$

Also the cross-section of the cone whose vertex is at the Earth's centre is $\mathrm{D}\left(\frac{r-r'}{r}\right)$. Therefore, the duration of a central transit of *Venus's* centre

$$= \frac{1}{\mathrm{V}}\left\{\frac{\mathrm{D}\,(r-r')}{r}\right\};$$

the duration of a central transit for external contacts

$$= \frac{1}{\mathrm{V}}\left\{\frac{\mathrm{D}\,(r-r')}{r} + \Delta'\right\};$$

the duration of a central transit for internal contacts

$$= \frac{1}{\mathrm{V}}\left\{\frac{\mathrm{D}\,(r-r')}{r} - \Delta'\right\};$$

all these phenomena being supposed to be seen from the Earth's

centre. To determine the interval between phenomena affected by parallax, we have, the section of the outer cone mentioned above

$$= \frac{D\,(r-r')}{r} + \frac{\Delta\, r'}{r};$$

the section of the inner cone mentioned above

$$= \frac{D\,(r-r')}{r} - \frac{\Delta\, r'}{r};$$

and it is readily seen that, for a central transit, the interval between first external contact most accelerated by parallax and last external contact most retarded, is

$$= \frac{1}{V}\left\{\frac{D\,(r-r')}{r'} + \frac{\Delta\, r'}{r} + \Delta'\right\};$$

the interval between first external contact most retarded by parallax and last external contact most accelerated, is

$$= \frac{1}{V}\left\{\frac{D\,(r-r')}{r} - \frac{\Delta\, r'}{r} + \Delta'\right\};$$

the interval between first internal contact most accelerated by parallax and last internal contact most retarded, is

$$= \frac{1}{V}\left\{\frac{D\,(r-r')}{r} + \frac{\Delta'\, r'}{r} - \Delta'\right\};$$

and, lastly, the interval between first internal contact most retarded by parallax and last internal contact most accelerated, is

$$= \frac{1}{V}\left\{\frac{D\,(r-r')}{r} - \frac{\Delta\, r'}{r} - \Delta'\right\}.$$

By taking the recognised values of D, Δ, Δ', v, d, d', and i; $r = \cdot 98480$ (the Earth's mean distance being unity), and $r' = \cdot 72040$, all the above intervals are readily calculated. The duration of a central transit of *Venus's* centre, seen from the Earth's centre, is found to be $7^h\ 55^m\ 8{\cdot}256^s$. A similar transit calculated for external contacts has a duration of $8^h\ 10^m\ 25^s{\cdot}140$, or 8·17365 hours. Since the duration of the transit of 1874, estimated for external contacts is 4·6525 hours, we have for determining the arc (2θ) of which the actual path of *Venus* is the chord,* the equation

* The arc and chord here referred to belong to a circle having a diameter of $\left\{D\,\frac{(r-r')}{r} + \Delta'\right\}$; but the position-angles eventually deduced may, of course, be referred to the Sun's disk.

$$\sin \theta = \frac{4{\cdot}6525}{8{\cdot}1736} = \sin 34^\circ\ 41'\ 40''\ \text{approximately};$$

and it is clear the distance separating the chord of transit from the centre of the section is

$$= \frac{1}{2}\left\{\frac{D\,(r-r')}{r} + \Delta'\right\}\ \cos \theta.$$

This distance is a constant in the calculation, and it will be convenient to call it k.

Now, if we want to determine the duration (t) of the transit of *Venus* across a section of any other radius, as s, and the corresponding arc of transit ($2\,\varphi$) we have the formulæ

$$\cos \varphi = \frac{k}{s};\ \text{and}\ t = \frac{2\,s \sin \varphi}{V}$$

We must give to $2\,s$, successively, the four values included in the expression

$$\left\{\frac{D\,(r-r')}{r} \pm \Delta\,\frac{r'}{r} \pm \Delta'\right\}.$$

In this way the durations were calculated which correspond to the epochs given in the accompanying table. For deducing position-angles from the arcs of transit, we have

The apparent angle at which *Venus* is ascending from the ecliptic towards the west

$$= i + \tan^{-1}\left\{\frac{d\,r'^2 \sin i}{\sqrt{d\,d'}\ r^2 - d\,r'^2 \cos i}\right\} = 9^\circ\ 9' +$$

The angle at which the elliptical diameter of the Sun is inclined to a declination-parallel (west end raised towards the north)

$$= 5^\circ\ 36'.$$

Therefore the apparent angle at which *Venus* is crossing a declination-parallel, rising towards the west, $= 14^\circ\ 45'$.

Thence it readily follows that the arc of transit $2\ (34^\circ\ 41'\ 40'')$ corresponds to the following position-angles,—

External contact at ingress, 130° 33′ from S. through E. towards N.
„ „ egress, 160° 4′ „ „ W. „

These values correspond satisfactorily with those given by Mr. Hind, viz. 130°·6 and 160°·0. The same angle 14° 45′ applied to the transit-arcs obtained in the other cases examined, gives the position-angles in the second column of the following table:—

Elements of the Transit of Venus, December 8th, 1874.

	G. M.T. h m s	Position angle. ° ′	
First external contact, most accel. by par.	13 37 35	128 48	from S. to E.
,, ,, from Earth's centre	13 46 56	130 33	,,
,, ,, most retarded by par.	13 57 47	132 41	,,
First internal contact, most accel. by par.*	14 3 59	133 56	,,
,, ,, from Earth's centre	14 15 57	136 28	,,
,, ,, most retarded by par.*	14 29 5	139 26	,,
Last internal contact, most accel. by par.*	17 43 58	168 57	from S. to W.
,, ,, from Earth's centre	17 57 5	165 59	,,
,, ,, most retarded by par.*	18 9 4	163 27	,,
Last external contact, most accel. by par.	18 15 15	162 12	,,
,, ,, from Earth's centre	18 26 5	160 4	,,
,, ,, most retarded by par.	18 35 26	158 19	,,

To which may be added,

First passage of ♀'s centre across Sun's limb	14 0 51	133 17	from S. to E.
Last ,, ,, ,,	18 12 11	162 48	from S. to W.

(both as seen from the Earth's centre).

The phenomena marked * are those which now concern us. We notice, first, that the maximum interval of time to be determined by the observations applied to the ingress and egress (internal contacts) is $25^m\ 6^s$. This is the interval which would result if each observation were made when the Sun is only raised above the horizon through the effects of refraction. A somewhat longer interval might be dealt with if the effects of refraction were considered, and if the observation of contact were possible when the Sun is close to the horizon. But we need not inquire into the possible extent by which the interval might thus be increased, since observations when the Sun is on the horizon are not available in the present instance. Practically we may consider that an interval of about 20^m has to be dealt with, or at the outside 22^m. As this interval is directly proportional to the solar parallax we can estimate the effect of errors of observation, or of error in the determination of the longitude of a station. An error of one second in the determination of an interval of 21^m would correspond to an error of about $0''{\cdot}007$ in the determination of the solar parallax.

(In an addendum to this Note, I propose to deal with the method of determining the solar parallax by difference of durations, so far as this method is applicable to the transit of 1874. Unless I mistake, I shall be able to show that more is to be hoped from the latter method, than from the one which is the object of the present investigation.)

To return to the consideration of the actual circumstances under which ingress and egress are most affected by parallax.

To determine the longitude and latitude of the four points on the Earth's surface at which the acceleration and retardation have their maximum values, we have the following formulæ—

Let P = the position-angle, measured from the south point.

δ = Sun's declination.

e = equation of time (additive to mean time).

h = hour at which a phenomenon (ingress or egress) occurs.

l = latitude of point required.

λ' = longitude of point required (l' being estimated from the meridian along which it is apparent noon at the epoch of the phenomenon).

Then $\sin l = \cos P \cos \delta$; and $\cot \lambda' = \cot P \sin \delta$.

I give the formulæ in this form as being that I have made use of. Strictly speaking, a reference should be made to the signs of l, λ'; but the circumstances of each case are quite sufficient to clear up any doubts which might arise. It is obvious that for the first and fourth phenomena marked * in the above table, the latitude is north, and for the others south; because, referring to the preliminary considerations it is seen that the tangent-lines corresponding to the former pair of phenomena belong to a cone whose vertex is outside the Earth, whereas the tangent-lines corresponding to the other phenomena belong to a cone whose vertex lies between the Earth and the Sun. From similar considerations it follows that the longitudes in the first and third cases are eastward of the meridian along which it is noon at the respective epochs, whereas, in the second and fourth cases, the longitudes are westward of the corresponding meridian. With this relation in view, the actual latitude (λ) east of Greenwich is given by the expression

$$\lambda = 24^h - (h + e) \pm \lambda'$$

(*Note.* e changes by a few seconds during the progress of the transit.)

Thus we obtain the following results:—

	Lat.	Long.
(i) The place at which first internal contact is most accelerated lies in	39 45 N.	143 23 W.
(ii) The place at which first internal contact is most retarded lies in	54 27 S.	29 1 E.
(iii) The place at which last internal contact is most accelerated lies in	64 47 S.	114 22 W.
(iv) The place at which last internal contact is most retarded lies in	62 5 N.	48 30 E.

On a comparison of these positions with those marked in Mr. Airy's maps I., II., III., IV., it will be noticed that the agreement is much closer for the places which fall in north latitude (that is,

cases I. and IV.) than for the other two. Indeed, as respects the two former positions there is little to affect the general conclusions which the Astronomer Royal has deduced from geometrical considerations. In the case illustrated by Plate I. the point marked with a small circle should be removed some 280 miles towards the north-west, rather westerly, and in the case illustrated by Plate IV. the corresponding point should be removed some 220 miles towards the north-east.

It is in the cases illustrated by Plates II. and III. that the most important changes have to be made. In the first the point marked with a circle should be removed to a distance of upwards of 800 miles towards the south-west. This change is unfavourable so far as the choice of stations for observing the retarded egress is concerned. Fort Dauphin in the Island of Madagascar (where, however, the Sun would be low at the time of internal contact at ingress) and Prince Edward and Marion Islands, are the places which, with Crozet's Island and Kerguelen's Land, are best placed for this observation.

In the case illustrated by Plate III. the change which should be made is not quite so large. The point marked with a circle should be shifted nearly 700 miles towards the south-east, rather easterly. This change is also unfavourable, as it removes the point further away from all the places mentioned by the Astronomer Royal. It follows that Auckland Island, Emerald Island, and Victoria Land, are the places best situated for observing the egress accelerated by parallax.

A portion of the corrections which have here been mentioned are due to the choice of internal contacts as the phenomena to be chiefly attended to. I believe no doubt can exist that this choice is a just and proper one. Indeed, so far as I am aware, no calculations for the determination of solar parallax have ever been founded on attempts to determine the epoch of external contacts.

In a subsequent paper I propose to present the results of calculations similar to the above, applied to the transit of 1882. I believe, however, that the corrections which have to be made in the case of that transit are less considerable than those dealt with above.

Addendum on the possibility of Determining the Solar Parallax by observations applied to the Transit of 1874 *of the same sort as those applied to the Transit of* 1769.

It occurred to me, while considering the relations presented in the above paper that there might possibly be some little inaccuracy in the Astronomer Royal's view that the transit of 1874 is altogether unfit for the determination of the difference between the Sun's parallax and the parallax of *Venus* by the method on which reliance was exclusively placed in the treatment of the observations of 1769. I have not seen the papers of May 8, 1857, and June 10, 1864, in which this view is presented; but I am told

that Lesson XLVI. of Mr. Lockyer's *Elementary Astronomy* is derived from the Astronomer Royal's papers. I conclude, therefore, that the consideration on which the view is founded is the following:—To determine the greatest difference in the length of the chords of transit, we must, if possible, select a place where both the ingress will be accelerated and the egress retarded, and another where the ingress is retarded and the egress accelerated. And I assume that the impossibility of finding two places which sufficiently fulfil these conditions in the case of the transit of 1874 is held to involve the failure of the method founded on the observed durations of transit.

It is unquestionably the case that no place can be found in northern latitudes which is at once near the point where ingress is most accelerated, and to the point where egress is most retarded. Nor can any spot be found near to the points where ingress is most retarded and egress most accelerated.

But this circumstance is counterbalanced by one which operates in another direction. In the case of the transit of 1874, the absolute maximum duration of transit, that is, the duration counted from ingress most accelerated to egress most retarded *for the whole earth*, differs very much more from the absolute minimum than in the case of the transit of 1882. For internal contacts the former difference exceeds the latter in the proportion of about three to two. This arises from the comparative shortness of the chord of transit in the case of the transit of 1874, and the increased effect which parallax consequently produces on its apparent length.

Hence it follows that although we cannot use anything like the full value of the difference in the case of the transit of 1874, we can yet obtain a resulting actual difference which is *fully equal* to that which we can obtain from the transit of 1882.

In order to test this view, I have made use of the following reductions for the effects of parallax, supplied with Mr. Hind's elements of the two transits:—

For the transit of *Venus* in 1874, the reductions for any place (taking ϱ = Earth's radius at the place; l = north latitude; and λ = latitude east of Greenwich), are

For Ingress.

External contact $-[2{\cdot}5621]\,\varrho \sin l - [2{\cdot}6872] \cos l \cos(\lambda - 137^\circ\ 1'.)$

For Egress.

External contact $+[2{\cdot}7213]\,\varrho \sin l + [2{\cdot}4833] \cos l \cos(\lambda - 38^\circ\ 20'.)$

In the case of the transit of 1882, the corresponding reductions are,—

For Ingress.

External contact $+[2{\cdot}5332]\,\varrho \sin l - [2{\cdot}4657]\,\varrho \cos l \cos(\lambda - 87^\circ\ 55'.)$

For Egress.

External contact $-[2{\cdot}2261]\,\varrho \sin l + [2{\cdot}6203]\,\varrho \cos l \cos(\lambda - 135^\circ\ 0'.)$

I find that, if we take for the northern station in 1874, a place on the continent of Asia about 45° north latitude, and 120° east longitude; and for the southern station a place on Sabrina Land in 66° south latitude and 135° east longitude, there results a difference of duration of transit, equal to about $23^m\ 23^s$. By taking the southern station in about the same latitude and 105° east longitude (the place pointed out by the Astronomer Royal as suitable for the southern station in 1882), the difference becomes diminished to $22^m\ 44^s$. By taking Crozet's Island or Kerguelen's Land for the southern station the difference still continues large, though somewhat diminished. But by taking a place somewhat to the south-west of Nicolaief (close to Saghalien Island) for the northern station, and a place in 66° south latitude, and 135° east longitude for the southern station, the difference is increased to no less than $26^m\ 30^s$ (at the northern station the Sun would be low at the time of external contact at egress). The southern station might also be taken at Enderby Land (66° south latitude, and 50° east) without reducing the difference more than one minute.

Now in the case of the transit of 1882 the places selected by the Astronomer Royal, as being absolutely the most favourable so far as difference of duration is concerned, are, the Island of Bermuda and Sabrina Land (in longitude 105° east); and these places give a total difference of duration of $25^m\ 49^s$, nearly 41″ *less* than the greatest difference obtained above for the transit of 1874.

It will be seen also that the method founded on observed differences in the duration of transit has altogether the advantage over the other method; since we have a larger period of time to deal with by some minutes, and there is not in the case of the former method the same necessity for a scrupulously exact determination of the longitude of the place of observation.

Since the above was written I have re-examined the whole subject by a new method, with results strictly accordant with those above obtained. But additional inquiry into the circumstances of the transit of 1874, with special reference to the question of duration, and for the case of internal contacts, has led me to still clearer evidence of the value of this transit. I have constructed the orthographic projections of the Earth for the epochs of first and last internal contacts as seen from the Earth's centre. Across these projections I have laid down the lines which mark the order of the occurrence of internal contacts as seen from different parts of the Earth's surface, from minute to minute. Thus, in the first projection I have a series of twenty-six lines commencing with a tangent to the Earth's north-easterly quadrant, 133° 56′ from the north, and ending with a tangent to the Earth's south-westerly quadrant, 139° 26′ from the south: in the second I have a similar number of lines commencing with a tangent to the Earth's south-easterly quadrant 165° 59′ from

the north, and ending with a tangent to the Earth's north-westerly quadrant 160° 4′ from the south. These lines enable one at once to recognise the best stations for observing the transit as most lengthened and as most shortened by parallax.

I find that any part of a nearly circular region extending from Lake Baikal to the southern part of Saghalien Island, and from north latitude 40° to north latitude 60° gives a well-lengthened transit, while the northernmost part of this region gives a lengthening of about $16\frac{1}{4}^{m}$. For southern stations there is a wide range of choice, though only three or four stations give nearly the full available shortening. I find, that Petra Island (assuming it rightly placed in my atlas, viz. in west longitude 88°, and south latitude 71°), gives a transit shortened by 20^{m}. The place near Repulse Bay mentioned by the Astronomer Royal as suitable for the observation of the transit of 1882, gives in 1874 a shortening of $18\frac{1}{2}^{m}$. The place near Victoria Land similarly referred to by Mr. Airy, gives a shortening of $18\frac{3}{4}^{m}$ in 1874. A place on Enderby Land will give a shortening of no less than $20\frac{1}{4}^{m}$. Crozet's Island and Kerguelen's Land are also suitable, giving transits shortened by 17^{m} and 16^{m} respectively. Macquarie Island, Royal Company Island, Hobart Town, and even parts of New Zealand, would serve as useful subsidiary stations.

The best southern station taken in conjunction with the best northern station gives a difference of duration of no less than $36\frac{1}{2}^{m}$. The maximum of difference in 1882 will be about 28^{m}. This is founded on the Astronomer Royal's statement that Sabrina Land and Bermuda give a difference which is to the absolute maximum of difference ($32\frac{3}{4}^{m}$ for internal contacts) as 341 to 400. Thus if we assume the value of a transit to be directly proportional to the observable difference of duration, the transit of 1874 is more valuable than that of 1882 in the proportion of $36\frac{1}{2}$ to 28, or more than 9 to 7. If, however, we hold that the slowness of ingress diminishes the value of a transit in precisely the same proportion that it increases the observable difference of duration, the transit of 1874 is inferior to that of 1882 in the proportion of

$$\frac{36\frac{1}{2}}{50\frac{1}{8}} \text{ to } \frac{28}{32\frac{3}{4}} \text{ or almost exactly 6 to 7.}$$

Probably the truth lies between these results, so that we may assign to the transit of 1874 a value which bears to that of 1882 the ratio of

$$\tfrac{1}{2}(9+6) \text{ to } 7, \text{ that is, } 15 \text{ to } 14.$$

Judged in either way the transit of 1874 is superior in value to that of 1769, *as actually utilized.*

In any case, it seems clear that the method founded on observed differences of duration is not inapplicable to the transit of 1874. On the contrary, when we remember all the difficulties in the way of the second method, the former seems to

be the one from which the most satisfactory results are to be expected.

Mr. Stone has obligingly called my attention to papers in the *Comptes Rendus* by M. Puiseux, in which the duration of transit has been calculated for 9 places in 1874, with the Sun's elevation at the epoch of each phenomenon. I have not yet had an opportunity of examining this paper, or noting how far its author's object has been similar to that which I have had in the discussion of the results contained in the latter part of the foregoing paper.

Limits of Total Phase of the Solar Eclipse, 1869, August 7.
By J. R. Hind, Esq.

From $8^h\ 51^m$ to $11^h\ 9^m$ G.M.T.

G.M.T.	Northern Limit. Long.	Northern Limit. Lat.	Central Line. Long.	Central Line. Lat.	Southern Limit. Long.	Southern Limit. Lat.	Dur. of Total Phase on Cen. Line.
h m	° ′	° ′	° ′	° ′	° ′	° ′	m s
8 51	135 41 E.	59 7 N.	140 12 E.	59 2 N.	144 1 E.	58 47 N.	2 35
8 53	140 59	60 22	144 53	60 3	148 20	59 39	2 41
8 55	145 31	61 20	149 4	60 53	152 14	60 21	2 46
8 57	149 38	62 8	152 55	61 34	155 52	60 56	2 51
8 59	153 29	62 47	156 32	62 7	159 17	61 25	2 55
9 1	157 9	63 20	159 59	62 36	162 31	61 50	2 59
9 3	160 39	63 48	163 17	63 0	165 38	62 10	3 2
9 7	167 15	64 31	169 31	63 36	171 33	62 40	3 10
9 11	173 26	65 0	175 23 E.	64 0	177 5 E.	63 0	3 16
9 15	179 17 E.	65 16	179 7 W.	64 12	177 44 W.	63 9	3 21
9 19	175 10 W.	65 22	173 54	64 15	172 48	63 10	3 26
9 23	169 55	65 19	168 58	64 10	168 8	63 3	3 30
9 27	164 55	65 9	164 16	63 59	163 42	62 51	3 34
9 31	160 12	64 50	159 49	63 41	159 30	62 32	3 38
9 35	155 44	64 27	155 37	63 17	155 31	62 8	3 41
9 39	151 31	63 58	151 37	62 48	151 44	61 40	4 43
9 43	147 32	63 24	147 51	62 15	148 8	61 8	3 45
9 47	143 46	62 47	144 16	61 39	144 43	60 32	3 47
9 51	140 12	62 5	140 51	60 59	141 28	59 53	3 48
9 55	136 49	61 20	137 37	60 15	138 22	59 11	3 48
9 59	133 36	60 32	134 32	59 28	135 24	58 26	3 49
10 3	130 33	59 41	131 35	58 39	132 33	57 38	3 49
10 7	127 38	58 47	128 46	57 47	129 49	56 48	3 49
10 11	124 50	57 50	126 3	56 53	127 11	55 55	3 48
10 15	122 7	56 52	123 25	55 56	124 38	55 1	3 47
10 19	119 30	55 51	120 52	54 57	122 9	54 4	3 45

From $8^h\ 51^m$ to $11^h\ 9^m$ G.M.T.

G.M.T.	Northern limit. Long.	Lat.	Central Line. Long.	Lat.	Southern Limit. Long.	Lat.	Dur. of Total Phase on Cen. Line.
h m	° ′	° ′	° ′	° ′	° ′	° ′	h m
10 23	116 57	54 48	118 22	53 56	119 42	53 5	3 43
10 27	114 27	53 42	115 55	52 53	117 18	52 4	3 41
10 31	111 58	52 34	113 30	51 47	114 56	51 0	3 38
10 35	109 31	51 23	111 5	50 39	112 34	49 54	3 35
10 39	107 2	50 9	108 40	49 27	110 10	48 45	3 31
10 43	104 32	48 53	106 12	48 13	107 46	47 33	3 27
10 47	101 57	47 32	103 40	46 56	105 18	46 19	3 22
10 51	99 15	46 8	101 2	45 34	102 42	45 0	3 16
10 55	96 23	44 39	98 13	44 8	99 58	43 37	3 10
10 59	93 14	43 2	95 12	42 36	97 3	42 9	3 4
11 1	91 31	42 11	93 34	41 27	95 28	41 22	3 0
11 3	89 41	41 16	91 49	40 55	93 48	40 32	2 56
11 5	87 40	40 18	89 56	40 1	92 0	39 40	2 52
11 7	85 26	39 16	87 51	39 3	90 2	38 45	2 48
11 9	82 52 W.	38 6 N.	85 31 W.	37 59 N.	87 52 W.	37 46 N.	2 44

Nautical Almanac Office,
1869, *March* 1.

Occultations of Stars observed at Waterloo, near Liverpool.
By John Joynson, F.R.A.S.

1868.			G.M.T. h m s	Nautical Almanac. h m	Angle given. °	
Dec. 27	B.A.C. 1526	Reap.	7 25 36·0	7 22	318	± 3m later, as it should be.
1869. Jan. 23	Aldebaran	Dis.	8 44 15·8	8 49	97	± 5m earlier; should be later.
		Reap.	±10 0 0	10 5	289	± 5m earlier; should be later.
24	115 Tauri	Dis.	5 27 5·0	5 29	52	± 2m earlier, as it should be.
		Reap.	6 16 38·6	6 12	333	± 3m later ,,
	119 Tauri	Dis.	8 17 25·7	8 14	143	± 3m later ,,
		Reap.	9 0 44·6	9 10	237	± 9m earlier ,, but hardly so much.
	120 Tauri	Dis.	8 46 27·4	8 48	117	± 2m earlier, should be later.
		Reap.	9 48 13·3	10 0	260	± 12m earlier, as it should be, but hardly so much as 12m ?

Lat. 53° 28′ 24″ N.
Long. $0^h\ 12^m\ 7^s$ W.

The reappearance of *a Tauri* (*Aldebaran*) could not be got exactly for passing cloud; but it was seen at $10^h\ 1^m$ G.M.T. about 75 seconds of arc from the limb; so that it must have reappeared rather before 10 P.M.

The times got on the 24th were deemed exact in each case, though in some cases they differ more than I think they should from the times stated in the *Nautical Almanac*.

Waterloo, Feb. 5, 1869.

Note on Personality in the Determination of the Line of Collimation of a Transit. By E. J. Stone, Esq.

A personality has been noticed between some observers in the determination of the line of collimation of a Transit instrument. The existence of such a personality to a sensible amount would be extremely difficult to deal with in a perfectly satisfactory manner: it would cast a certain amount of doubt over the whole of the instrumental corrections. I have thought it worth while, therefore, to determine whether such a personality exists between the Greenwich observers. The observations at Greenwich are chiefly made by Messrs. Dunkin, Ellis, Creswick, and James Carpenter. The collimation error of the Transit-circle is determined on every day except Sundays. It is usual, unless there are indications of a real change, to adopt the mean of the readings made during a week as the true reading for the line of collimation to be used in reduction of the observations made during the week. We shall have, therefore, in many cases, a collimation reading made by Messrs. Dunkin, Ellis, Creswick, and Carpenter, all within a week, and generally two collimation determinations by one or other of these gentlemen within the week. These duplicate determinations are valuable for testing the stability of the line of collimation during the week. I have adopted the mean of such duplicate determination for the observers' reading for the week's comparison. In the last two years I have found 38 of these complete weekly comparisons. These 38 comparisons, split up into three sections of 11, 16, and 11 comparisons, give results so closely agreeing with the means of all, that I have not thought it necessary to extend the comparisons.

The following are the corrections to the adopted readings, as determined by Messrs. Dunkin, Creswick, Ellis, and Carpenter:—

Correction from Mr. Dunkin's Observations		$+0^{r}.021$
Mr. Ellis'	,,	$+0^{r}.024$
Mr. Creswick's	,,	$+0^{r}.014$
Mr. Carpenter's	,,	$+0^{r}.018$

or, taking the deviation from the mean as error of each observers' method, we have

		s		s
For	Mr. Dunkin	+0·002	=	0·030
	Mr. Ellis	+0·005	=	0·075
	Mr. Creswick	−0·005	=	−0·075
	Mr. Carpenter	−0·001	=	−0·015

The greatest difference is between Mr. Ellis' and Mr. Creswick's determinations, but these differ by only 0″·15.

This quantity, small as it really is, is real. Each of the three sub-groups gives a result of the same sign, agreeing closely in amount, and an independent comparison of 51 consecutive readings of C. and E. gives a similar result. The magnitudes of these discordances are so small, that they may fortunately be most safely neglected. The result appears to be, that, so far as Greenwich is concerned, the uncertainties introduced into the collimation determinations by personality are insignificant.

On an extensive Train of Sun-spots. By John Browning, Esq.

About noon, on the 7th of March, I saw a long train of Sun-spots through the finder of my Equatoreal.

Attempting to observe them with my 12-inch silvered-glass reflector, I found the definition so bad that I was compelled to reduce the aperture to 6 inches before I could obtain tolerably steady vision. I then fitted a solar plane, that is a plate of parallel glass silvered on the exposed surface, on to the mouth of the telescope.

With a parallel-wire micrometer I measured the spots, and made the accompanying drawing to scale, see Plate.

They presented the appearance of an almost continuous penumbra, in an irregular hollow curved line, with umbræ at intervals. Some of these umbræ contained blacker nuclei.

On the western side a portion of the penumbra assumed the form of a pair of compasses.

I found the outside dimensions of the cluster to be from E. to W. 97,700 miles, and from N. to S. 27,130 miles. This is by far the largest group of spots I have seen during the recent outbreak. Taking a mean line through the group, they were almost exactly parallel to the Sun's equator.

A few bright bridges crossed some of the penumbræ, but no fine stipplings such as I have mostly seen were visible on them. The air was, however, so unsteady that I could only use a power of 127. A higher power than this would probably have been necessary to make them perceptible. The coarse mottlings were easily seen all over the solar surface.

In the case of some of the previous spots I observed that when they were near the centre of the solar disk but few bright faculæ could be seen surrounding the penumbra. As these spots

approached closely to the Sun's limb the faculous matter became brighter and brighter, until when the spots had reached the limb it quite obliterated the penumbra. The black spots were then seen surrounded by a bright border. This is a proof, if any is needed, that the faculæ are far above the solar surface.

On an Improved Method of Mounting Finders.

By John Browning, Esq.

The manner of mounting a finder may seem too small a matter to bring before the Royal Astronomical Society, yet when it is considered that a valuable observation may be lost merely from a finder being out of adjustment, it will at once be admitted that the matter is one well worthy of attention.

Professor Piazzi Smyth wrote me a short time since "that he thought some better plan for mounting and adjusting finders was much required." This induced me to devise the contrivance I shall presently describe.

Two plans are in general use for adjusting finders, both of which have obvious disadvantages. In the first the finder is placed in the centre of two rings somewhat larger than itself, and adjusted by means of three screws working through each ring, and pressing on bands which serve to strengthen the finder. This adjustment is liable to the following objections:—The rings prevent a line of sight being taken along the body of the finder; the screw-points are apt to shift their position on the rings, even if resting in groves, should the observer inadvertently attempt to direct the telescope by means of the finder. Like all three-screw adjustments, several trials have generally to be made before an error can be rectified.

The second plan consists in attaching the finder to the body of the telescope as a fixture, on two uprights. The adjustment in this case is made by moving a stop carrying the cross-wires placed in the focus of the eye-piece, by means of screws which pass through the body of the finder. In most respects this plan is good, but it has the serious objection of considerably limiting the field of view. Of course the largest attainable field of view is required in a finder.

The plan figured in the Plate seems to me to avoid the whole of the foregoing objections.

Fig. 1 represents the finder (A A) mounted by the aid of the uprights (B B) on the telescope (T T). The finder has two semicircular bands (F F) round the lower half of the body. The upright (B) has two hollow gun-metal screws (C C), which work in bosses at the sides. These screws press against the stout semicircular band (F), and serve to move the finder horizontally. Two smaller steel screws pass through the gun-metal screws, and are themselves screwed into the band (F) on the finder. The con-

struction of these double screws is shown in fig. 4, where G is the hollow screw, the end of which acts against the band, and (H) the central screw which clamps into the finder.

Fig. 2 is a section of the finder and upright, as well as the clamping and adjusting screws, at the point B.

The vertical adjustment is effected by means of a similar pair of screws, as at D, fig. 3.

It will be evident from the construction that when the finder is being moved vertically it will swivel slightly on the horizontal screws, C C, while, when it is being moved horizontally, it will swivel on the vertical clamping screw, D, fig. 3; thus no undue strain will be thrown on any part.

I have the honour of exhibiting a 2-foot finder mounted in this manner, and I think a trial of its firmness will convince any one that it would not be possible, except by breaking or bending some of its parts, to put it out of adjustment.

When using a star-spectroscope attached to a telescope it is necessary to bring the star or other object under examination exactly between the jaws of the slit of the spectroscope, *or no spectrum will be visible.* This is a task of exceeding difficulty, unless the finder on the telescope will remain accurately in adjustment. For such a purpose a finder mounted as described would be valuable.

The Johnson Memorial Prize.

The Trustees of the Johnson Memorial Prize for the encouragement of the study of Astronomy and Meteorology, propose the following subject for an Essay:—

"*On the Laws of Wind.*

"1. With regard to Storms.

"2. With regard to average Periodical Phænomena at given places on the Earth's Surface."

The Prize is open to all Members of the University of Oxford; and consists of a Gold Medal of the value of Ten Guineas, together with so much of the dividends for four years on 338*l.* Reduced Annuities as shall remain after the cost of the Medal and other expenses have been defrayed.

Candidates are to send their Essays to the Registrar of the University under a sealed cover, marked "Johnson Memorial Prize Essay," on or before the 31st day of March, 1871, each Candidate concealing his name, distinguishing his Essay by a motto, and sending at the same time his name sealed up under another cover with the same motto written upon it.

No Essay will be received after the 31st day of March, 1871.

CONTENTS.

Page

Fellows elected 193

On the Aden and Guntoor Photographs of the Eclipse of the Sun, August 18, 1868, by Mr. De La Rue . .. . ib.

On the Transit of *Mercury* in 1868, and on γ^1, γ^2, γ^3 *Andromedæ* in Daylight, by Mr. Barneby 194

Observations on the Transit of *Mercury*, 5th November, 1868, Hobart Town, by Mr. Abbott 195

Observations of the Transit of *Mercury* over the Sun's disk on November 4th, 1868, at the Royal Observatory, Cape of Good Hope, with Equations deduced therefrom, by Mr. Mann 196

On the Observations of the Transit of *Venus* in 1874, by the Astronomer Royal 210

Note on the Transit of *Venus* in 1874; and an exact determination of those points on the Earth's surface at which internal contacts are most accelerated and retarded by Parallax. With an Addendum referring to the possibility of determining the Solar Parallax by the same sort of Observations in 1874 as were made in 1769, by Mr. Proctor.. 211

Limits of Total Phase of Solar Eclipse, 1869, August 7, by Mr. Hind .. 222

Occultations of Stars observed at Waterloo, near Liverpool, by Mr. Joynson 223

Note on Personality in the Determination of the Line of Collimation of a Transit, by Mr. Stone 224

On an extensive Train of Sun-spots, by Mr. Browning 225

On an improved method of mounting Finders, by Mr. Browning.. .. 226

The Johnson Memorial Prize 227

Printed by STRANGEWAYS AND WALDEN, Castle Street, Leicester Square, and Published at the Apartments of the Society, April 7, 1869.